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Indian Standard

TOLERANCES FOR CASTINGS AND FINISHING OF SHIPS' SCREW PROPELLERS

PART I PROPELLERS OF DIAMETER BETWEEN 0·8 AND 2·5 METRES

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TOLERANCES FOR CASTINGS AND FINISHING OF SHIPS' SCREW PROPELLERS

PART I PROPELLERS OF DIAMETER BETWEEN 0·8 AND 2·5 METRES

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Indian Standard

TOLERANCES FOR CASTINGS AND FINISHING OF SHIPS' SCREW PROPELLERS

PART I PROPELLERS OF DIAMETER BETWEEN 0·8 AND 2·5 METRES

0. FOREWORD

0.1 This Indian Standard (Part I) was adopted by the Indian Standards Institution on 30 March 1979, after the draft finalized by the Shipbuilding Sectional Committee had been approved by the Marine, Cargo Movement and Packaging Division Council.

0.2 Adoption of too severe tolerances for acceptance of screw propellers may result in increased manufacturing costs with no corresponding increase in the performance of the finished propellers. Therefore, there is a need for a range of propeller tolerances which are expected to produce satisfactory results depending on the operation of various kinds of propellers.

0.3 This standard is based on 'ISO/DIS 484 (Part II) Shipbuilding—Ship screw propellers — Manufacturing tolerances for castings and finishing — Part II : Propellers of diameter between 0·8 m and 2·5 m', issued by the International Organization for Standardization (ISO).

0.4 This standard is one of a series of Indian Standards on ships' screw propellers. Other standards in the series are:

IS : 8215-1976 Glossary of terms for ships' propellers

IS : 9126 (Part II)-1979 Tolerances for castings and finishing of ships' screw propellers : Part II Propellers of diameter greater than 2·5 metres

IS : 9126 (Part III)-1979 Tolerances for castings and finishing of ships' screw propellers : Part III Methods of test for propellers.

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1. SCOPE

1.1 This standard (Part I) specifies tolerance limits for each of the parameters of the screw propellers meant for ocean going ships as well as river craft of diameters between 0·8 to 2·5 m.

1.2 This standard applies to solid cast built-up and controllable pitch propeller of any material.

2. TERMINOLOGY

2.1 For the purpose of this standard the following definitions, in addition to those given in IS : 8215-1976*, shall apply.

2.1.1 *Mean Pitch per Blade* — The arithmetic mean of the pitches per radius and per blade for the blade in reference.

2.1.2 *Mean Pitch for the Propeller* — The arithmetic mean of the mean pitches per blade.

3. CLASS OF ACCURACY

3.1 The class of accuracy of manufacture propellers shall be according to Table 1. Specific class of accuracy for the manufacture of propeller shall be as per purchaser's choice.

TABLE 1 CLASS OF ACCURACY

CLASS (1)	MANUFACTURING ACCURACY (2)	RECOMMENDED USE (3)
S	Very high	Propellers of superior quality for special purposes
I	High	For majority merchant vessels
II	Medium	
III	Wide tolerance	For vessels without special characteristics, in general applied to cast iron propellers

4. TOLERANCES

4.1 Radius of the Screw Propellers — The tolerance for the radius of the screw propeller shall be as given in Table 2.

4.2 Pitch — The tolerance on pitch when measured according to the method described in IS : 9126 (Part III)-1979† shall be according to Table 3.

4.2.1 The pitch shall be measured at least at the radii as given in Table 4.

---

*Glossary of terms for ships' propellers.

†Tolerances for castings and finishing of ships' screw propellers: Part III Methods of measurement.

TABLE 2 TOLERANCE FOR RADIUS OF PROPELLER

(*Clause* 4.1)

CLASS OF ACCURACY	TOLERANCE	
	Percent	mm
(1)	(2)	(3)
S	± 0·2	1·5
I	± 0·3	1·5
II	± 0·4	2·0
III	± 0·5	2·5

NOTE 1 — Tolerance in col 2 is expressed as percentage of the screw propeller radius. In case of the ducted propellers this tolerance may be reduced.

NOTE 2 — The values given in col 3 indicate minimum permissible value of the tolerance.

TABLE 3 TOLERANCE ON PITCH

(*Clause* 4.2)

SL No.	PITCH DESIGNATION	TOLERANCE FOR CLASS							
		S		I		II		III	
		Percent*	mm†	Percent*	mm†	Percent*	mm†	Percent*	mm†
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	Local pitch	±1·5	10·0	±2·0	15·0	±3·0	20·0	—	—
ii)	Mean pitch per radius per blade	±1·0	7·5	±1·5	10·0	±2·0	15·0	±5	25
iii)	Mean pitch per blade	±0·75	5·0	±1·0	7·5	±1·5	10·0	±4	20
iv)	Mean pitch per propeller	±0·5	4·0	±0·75	5·0	±1·0	7·5	±3	15

*The tolerance in this column is expressed as percentage of the design pitch at the corresponding radius for Sl No. (i) and (ii) and of the mean design pitch for Sl No. (iii) and (iv).

†The values in this column indicate minimum tolerance permissible.

4.2.2 The measurement of local pitches is not required when the form of the sections is measured in accordance with **2.3** of IS : 9126 (Part III)-1979*.

---

*Tolerances for castings and finishing of ships' screw propellers: Part III Methods of measurement.

TABLE 4 RADII WHERE THE PITCH SHOULD BE MEASURED

(*Clause* 4.2.1)

CLASS OF ACCURACY (1)	RADII (IN TERMS OF *R**) (2)
S and I	A section near the hub, 0·4, 0·5, 0·6, 0·7, 0·8, 0·9 and 0·95
II and III	A section near the hub, 0·5, 0·7 and 0·9

**R* is the radius at blade tip.

4.2.3 The tolerances on the local pitch and on the mean pitch per radius per blade given in Table 3 at Sl No. (i) and (ii) may be increased by 50 percent for sections near the hub and 0·4 *R*.

4.2.4 Should the propeller manufacturer wish to compensate for an error on the pitch (inside or outside the tabulated tolerances) by means of an alternation in the propeller diameter, it may be due with the customer's agreement.

4.3 Thickness of Blade Section — The tolerance on the thickness of the blade section measured according to the method described in IS : 9126 (Part III)-1979* shall be as specified in Table 5.

TABLE 5 TOLERANCE ON THICKNESS OF BLADE SECTION

CLASS OF ACCURACY	THICKNESS	
	Percent	mm
(1)	(2)	(3)
S	+ 2 − 1	+ 0·5 − 0·5
I	+ 2·5 − 1·5	+ 1·0 − 1·0
II	+ 4 − 2	+ 2·0 − 1·5
III	+ 6 − 4	+ 3·0 − 2·0

NOTE 1 — The tolerance in col 2 is expressed as percentage of local thickness of the corresponding blade section.

NOTE 2 — The values given in col 3 indicate minimum permissible value of the tolerance.

---

*Tolerances for castings and finishing of ships' screw propellers: Part III Methods of measurement.

4.3.1 The thickness shall be measured at the same radii at which the pitch is measured.

4.4 Length of the Blade Section — The tolerance on the length of the blade section shall be in accordance with Table 6.

TABLE 6 TOLERANCE ON THE LENGTH OF THE BLADE SECTION

CLASS OF ACCURACY	TOLERANCE	
	Percent	mm
(1)	(2)	(3)
S	± 1·5	4
I	± 2	7
II	± 3	10
III	± 5	12

NOTE 1 — The tolerance in col 2 is expressed as percentage of the value of the ratio of the diameter to the number of blades (D/Z).

NOTE 2 — The values given in col 3 indicate minimum permissible value of the tolerance.

4.4.1 The length of the blade section of each blade shall be measured at 5 radii at least for Class S (for example, 0·3 *R*, 0·5 *R*, 0·7 *R*, 0·8 *R* and 0·95 *R*) and 4 radii for Class I.

4.5 Location of Blades, Location of Reference Lines, and of Blade Contours

4.5.1 *Marking of Lines of Reference* — The reference line is a straight line shown on the drawing and passing through a point *M* on the pressure side of the blade. This point *M* should be marked on a cylindrical section at a radius greater than 0·5 *R* and, if possible, in the region of 0·7 *R*. It is selected in such a way that the line *OM* cuts the largest possible blade section. The ratio between the angles φ_E (leading edge) and φ_S (trailing edge) is indicated in Fig. 1.

4.5.1.1 Point *M'* on the manufactured propeller is determined in such a way that a ratio φ'_E/φ'_S equal to a ratio φ_E/φ_S stated on the drawing can be obtained at the radius in question (*see* Fig. 2). The reference planes through points *M'* are used to check the shape of the leading edge and blade skewback (*see* IS : 8215 - 1976*) as well as the blade angular deviation.

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*Glossary of terms for ships' propellers.

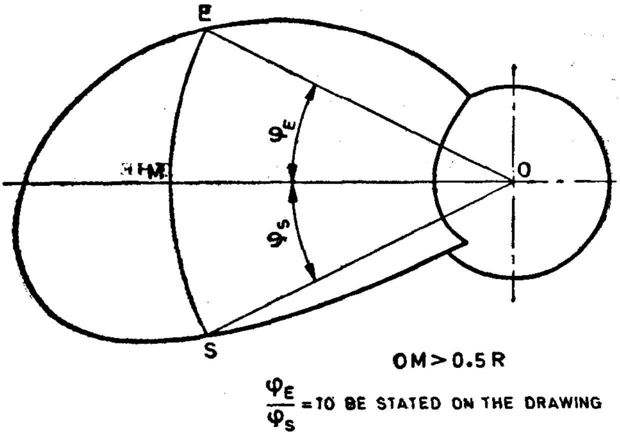

FIG. 1 MARKING OF LINES OF REFERENCE

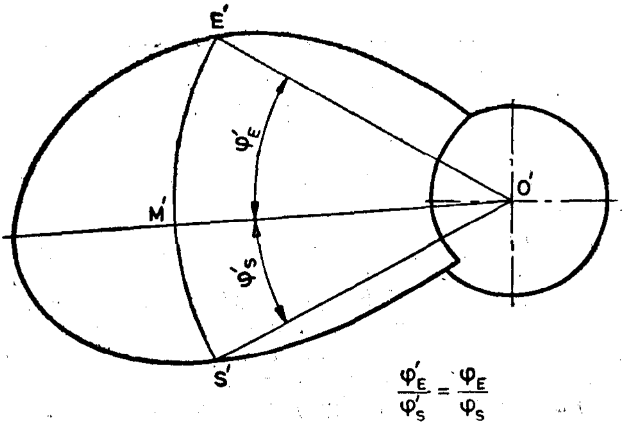
E'
M'
O'
φ'_E
φ'_S
S'
$\frac{\varphi'_E}{\varphi'_S} = \frac{\varphi_E}{\varphi_S}$

FIG. 2 MARKING OF LINES OF REFERENCE

4.5.2 *Tolerances on the Contour of the Leading Edge* — The tolerances shall be calculated on the radii according to Table 4 on the corresponding arcs and are valid for the arc lengths *E'S'* (*see* Fig. 2). They are expressed in percentages of D/Z in Table 6 (D = diameter, Z = number of blades). The tolerances for the distance *E'S'* shall be double the values given in Table 6.

4.5.3 *Tolerances on the Angular Deviation Between Two Consecutive Blades* — The tolerances shall be:

a) 1° for Classes S and I, and

b) 2° for Classes II and III.

4.6 Blade Inclination — The tolerance on blade inclination shall be as given in Table 7 when measured by the method described in IS : 9126 (Part III)-1979*.

TABLE 7 TOLERANCE ON BLADE INCLINATION

CLASS OF ACCURACY	TOLERANCE PERCENT
(1)	(2)
S	± 0·5
I	± 1
II	± 1·5
III	± 5

NOTE — The tolerance in this table is expressed as percentage of propeller diameter *D*.

4.7 Surface Finish — The arithmetic mean deviation *R*a microns to be adopted according to the class of screw propellers shall have the following maximum values and roughness grade number in accordance with IS : 696-1972†:

Class of Accuracy	*Ra*	*Roughness Grade Number*
S	3·2 from the hub to tip	N8
I	6·3 from 0·3 *R* to tip	N9
II	12·5 from 0·4 *R* to tip	N10
III	25 from 0·5 *R* to tip	N11

5. STATIC BALANCING

5.1 When finished, all screw propellers shall be statically balanced.

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*Tolerances for castings and finishing of ships' screw propellers: Part III Methods of measurement.

†Code of practice for general engineering drawings (*second revision*).

5.1.1 The balancing mass P (in kg) at the tip of the propeller blade is defined by the following formulae:

$$P = C \times \frac{m}{Rn^2}$$

where

m = mass in kg of propeller;
R = radius in m at blade tip;
n = design rpm of the propeller; and
C = a factor depending on the class of propeller and is given in Table 8.

TABLE 8 VALUE OF C

CLASS	C
(1)	(2)
S	15
I	25
II	40
III	75

5.1.2 The minimum values of P shall be as follows:

a) 0·05 percent of m for Class S,
b) 0·075 percent of m for Class I, and
c) 0·1 percent of m for Classes II and III.

NOTE 1 — The accuracy of measurement of the balancing apparatus should be at least half of the balancing mass.

NOTE 2 — In the case of a controllable pitch or built-up propeller, the manufacturer shall satisfy the user that the assembled propeller will be in accordance with the requirements of this clause.

NOTE 3 — The above table applies only to propellers where the tip speed does not exceed 60 m/s. Other means of balancing should be considered for propellers outside this range.